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STATUS REPORT
The Physical Elements of Onset of the Magnetospheric Substorm

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During this reporting period effort continued in the related areas: (1) understanding the mechanisms responsible for substorm onset, and (2) the fundamental description of field-aligned currents and parallel electric fields.

1. A Mechanism for Magnetospheric Substorms

Effort continued toward understanding the role of the various mechanisms suggested as responsible for onset of the magnetospheric substorms in the contexts of M-I coupled convection and the large-scale stability of the magnetosphere. We argue that the various mechanisms, M-I coupling, currrent-driven resistivity, and tearing must operate in concert to account for a substorm expansion. This is the central theme of a report delivered at last summer's GEM meeting and a contribution to this year's quadrennial report to the IUGG.

Our idea as to the triggering mechanism of the substorm has been summarized in earlier reports. We suggest that the growth of parallel potential drops in association with upward field-aligned currents can destabilize the inward/outward oscillation of near-Earth plasma-sheet flux tubes. Sufficient outward displacement puts the near-Earth plasma sheet out of its quasi-static pressure balance with the tail lobes. We have been collaborating with Nelson Maynard, Bill Burke and others in interpreting CRRES data preceding and during substorm expansions. CRRES electric field data often show inward/outward flux-tube oscillation of finite amplitude prior to substorm onset. A reversal of the dawn-dusk electric field is often seen as an immediate precursor of dipolarization. There is one event when CRRES appears to be in the midst of the onset region in the plasma sheet which seems to fit our onset scenario very well. We will construct a physical model of oscillating plasma sheet flux tubes to compare to the electric and magnetic field perturbations observed at CRRES for this event.

2. The Fundamental Description of Field-Aligned Currents and Parallel Electric Fields in Magnetospheric Plasma

The paper "Inertial Currents in Isotropic Plasma" by M. Heinemann, G. M. Erickson, and D. H. Pontius Jr. has been published in *Journal of Geophysical Research.* The new finding relating the role of polarization in steady-state isotropic plasma to the development of field-aligned currents and electric fields was contained in the last report. A reader-friendly version of this paper, "Parallel Electric Fields in Isotropic Plasma", uncomplicated by mathematics, was revised for *Geophysical Research Letters.* While the *JGR* paper had challenging referees who we successfully satisfied and a talk at the last Spring AGU Meeting received a warm reception, the *GRL* referees rejected the paper. We will try again to publish the reader-friendly version. The next challenge is to extend the work to explicitly include gradient and curvature drifts.

Publication Summary:

Erickson, G. M., Substorm Theories: Are They Converging, in *Strategies for the Tail and Substorm Campaign*, edited by W. J. Hughes, pp. 45–64, Boston University Center for Space Physics, Boston, 1993. (Reprint last report.)

Burke, W. J., J. S. Machuzak, N. C. Maynard, E. M. Basinska, G. M. Erickson, R. A. Hoffman, J. A. Slavin, and W. B. Hanson, Electrodynamic Signatures of the Plasma Sheet Boundary Layer in the Evening Ionosphere, in *Physical Signatures of Magnetospheric Boundary Layer Processes*, Vol. 425, NATA Advanced Science Institute Series, edited by J. A. Holtet and A. Egeland, pp. 111–123, Kluwer Academic Publishers, Dordrecht, 1994. (Preprint last report.)

Heinemann, M., G. M. Erickson, and D. H. Pontius, Jr., Inertial Currents in Isotropic Plasma, *J. Geophys. Res., 99*, 8634–8646, 1994. (Reprint enclosed.)

Erickson, G. M., and M. Heinemann, A Mechanism for Magnetospheric Substorms, in *Substorms II*, in press. (Preprint enclosed.)

Erickson, G. M., and M. Heinemann, The Stability of Sunward Convection: An Operative and Triggering Mechanism for Substorms, prepared for the GEM Tail and Substorm Campaign, Snowmass, 30–31 June 1994. (Copy enclosed).

Erickson, G. M., Substorm Theories: United They Stand, Divided They Fall, in *U.S. National Report to the IUGG (1991–1994)*, AGU, Washington, D.C., revised. (Preprint enclosed.)

Hau, L.-N., and G. M. Erickson, Plasma Sheet Convection With Magnetic B_y Component, *Geophys. Res. Lett.*, in preparation.

Presentations:

Heinemann, M., D. H. Pontius Jr., and G. M. Erickson, Parallel Electric Fields in Isotropic Plasma, AGU Spring Meeting, 23–27 May 1994.

Erickson, G. M., Inertial Currents in Isotropic Plasma, Rice University, Dept. Space Physics and Astronomy, 26 April 1994.

Erickson, G. M., A Mechanism for Magnetospheric Substorms, Rice University, Dept. Space Physics and Astronomy, 27 April 1994.

Erickson, G. M., Extending the MSFM to Low-Latitude/Ground, GEM GGCM/WG1, Snowmass, 29 June 1994.

Erickson, G. M., Putting the Substorm into the Modularized GGCM, GEM GGCM/WG3, Snowmass, 29 June 1994.

Erickson, G. M., Limitations of Ideal MHD, GEM Tail-Substorm/WG2, Snowmass, 30–31 June 1994.

Erickson, G. M., and M. Heinemann, The Stability of Sunward Convection: An Operative and Triggering Mechanism for Substorms (Poster), GEM Tail-Substorm, Snowmass, 30–31 June 1994.